Disordered Eating, Body Mass, and Glycemic Control in Adolescents With Type 1 Diabetes

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OBJECTIVE — To examine the relationship between disordered eating attitudes and behaviors, BMI, and glycemic control in adolescents with type 1 diabetes.

RESEARCH DESIGN AND METHODS — In a cross-sectional design, 152 adolescents (ages 11–19 years) completed three scales from the Eating Disorders Inventory (EDI): Body Dissatisfaction, Drive for Thinness, and Bulimia. All subjects had diabetes for >1 year. Glycemic control was assessed by glycosylated hemoglobin (HbA_{1c}). Height and weight were measured to assess BMI.

RESULTS — Adolescents with type 1 diabetes did not report more disordered eating attitudes and behaviors than the normative comparison sample. Male subjects with type 1 diabetes reported fewer symptoms of bulimia and female subjects with type 1 diabetes reported greater body satisfaction than the normative group. A higher BMI was a significant predictor of greater body dissatisfaction, more so for female than male subjects. Symptoms of bulimia were associated with older adolescence and female sex. Those with more symptoms of bulimia were also more likely to have a higher BMI. Sex (female) and body dissatisfaction (more dissatisfied) predicted a stronger desire to be thin. Longer duration of disease, more symptoms of bulimia, and obesity all predicted poorer glycemic control.

CONCLUSIONS — Female patients aged 13–14 years seem to be at greatest risk for developing disordered eating patterns. Using the clinical cutoff score (≥5) of the EDI Bulimia subscale as a screener in diabetes clinics may help identify adolescents whose disordered eating patterns are likely to compromise their glycemic control.

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Considering the importance of diet in the management of type 1 diabetes, it is believed that patients with this disease are at an increased risk for developing eating disorders, specifically anorexia nervosa and bulimia nervosa (1). However, the literature has been inconclusive, with some studies demonstrating a higher prevalence of eating disorders in patients with type 1 diabetes (2–7) and other studies reporting no difference between those with and without type 1 diabetes (8–13).

Although it is unclear whether eating disorders are more prevalent among patients with type 1 diabetes, eating disorders per se do seem to be associated with poorer glycemic control and increased risk for complications (4,7,8,10,14). For example, Rydall et al. (15) reported that 86% of young women who displayed high levels of disordered eating developed retinopathy after 5 years compared with only 24% of women with normal eating patterns. Further, insulin omission or dose manipulation offers a unique form of purging to those with diabetes. Studies suggest that this occurs in 15–40% of young women with diabetes (6,9,10).

The identification and treatment of disordered eating attitudes and behaviors may become increasingly important in light of current recommended use of intensive therapy following the publication of the Diabetes Control and Complications Trial (DCCT) results. Although the DCCT demonstrated that intensive therapy significantly reduced diabetes-related complications, one of its side effects was significant weight gain. Among adolescents in the DCCT, 48% became overweight compared with 28% of those offered conventional care (16). Others have since confirmed greater weight gain in patients treated with intensified insulin regimens compared with conventional care (17). This weight gain could increase the likelihood of problematic eating attitudes and behaviors, particularly among female adolescents.

Adolescence is a developmental period in which body image is of particular concern, and the increased prevalence of eating disorders in females during this developmental period has been well documented (7,18,19). The available literature suggests that body size (including weight gain), body image (including body dissatisfaction), adolescent age, and female sex are all predictive of disordered eating attitudes and behaviors in both healthy subjects and those with diabetes (2,3,7, 11,19).

The purposes of this study were *1*) to examine body image and disordered eating attitudes and behaviors in a large sample of adolescents with type 1 diabetes, *2*) to identify predictors of body dissatisfaction and disordered eating, and *3*) to examine the relationship of disordered eating to glycemic control.

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Abbreviations: DCCT, Diabetes Control and Complications Trial; EDI, Eating Disorders Inventory.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

Table 1—*Demographic characteristics of the study sample*

Variable	Percentage	Mean	SD
Child sex			
Male	54		
Female	46		
Child race			
White	81.7		
Black	8.5		
Other	9.7		
Child's current age (years)		14.45	1.99
Duration of disease (years)		6.08	3.49
Tanner stage			
1	5.4		
2	10.9		
3	14.0		
4	27.1		
5	42.6		
HbA_{1c} (%)		9.04	1.67
BMI (kg/m^2)		22.02	4.36

RESEARCH DESIGN AND METHODS

Subjects

Adolescents (ages 11–19 years) with type 1 diabetes (duration >1 year) were recruited from diabetes specialty clinics at two different sites: University of Florida Health Science Center, Gainesville, FL ($n = 99$); and Nemours Children's Clinic, Orlando, FL ($n = 53$). Of the study participants, 54% were female and 81.7% were white. At the time of this study, participants had been receiving conventional care with two injections of insulin per day and two to four blood glucose tests per day. All participants were being considered for intensive therapy. However, all study assessments described herein were conducted before intensive therapy was initiated. A summary of patient characteristics is shown in Table 1. Adolescent assent and parental consent to participate were obtained in accordance with the requirements of the Institutional Review Boards at both sites.

Measures

The following patient information was obtained during a regularly scheduled clinic visit: age, sex, Tanner stage, height and weight (used to calculate BMI), and duration of disease. Glycemic control was measured by the glycosylated hemoglobin assay (HbA_{1c}) conducted at the Shands Core Laboratory using high-performance liquid chromatography (reference range 4.5–6.1%).

Patients completed the Eating Disorders Inventory (EDI), a self-report questionnaire measuring attitudes, feelings, and behaviors characteristic of individuals with eating disorders (20). Three subscales were used in the present study: Body Dissatisfaction, Drive for Thinness, and Bulimia. A high score on the Body Dissatisfaction subscale confirms perceptions that specific parts of the body, associated with shape change during puberty (e.g., hips, thighs, buttocks) are too large. A high score on the Drive for Thinness subscale indicates excessive concerns with dieting, a preoccupation with weight, and an extreme pursuit of thinness. A high score on the Bulimia subscale is indicative of uncontrollable eating episodes that may be followed by the desire to self-induce vomiting (21). To measure the internal consistency of the EDI scales, a series of coefficient αs were calculated for this sample. All of the subscales were found to be highly reliable (Body Dissatisfaction $\alpha = 0.89$, Drive for Thinness $\alpha = 0.77$, Bulimia $\alpha = 0.72$). Normative comparison data obtained from healthy adolescents are available (22). Furthermore, clinical cutoff scores have been developed for both the Body Dissatisfaction and Bulimia subscales (4). Two additional questions asking about insulin manipulation were included on the EDI ("I skip insulin shots to lose weight" and "I take less insulin than I am supposed to, to lose weight"). Participants responded to questions on a six-point Likert scale; response options ranged from "always" to "never").

Statistical analysis

A series of Welch's *t* tests (23) were conducted comparing the mean scores on each EDI scale in our type 1 diabetes sample with norms established for healthy adolescents (22); male and female subjects were evaluated separately (Table 2).

Hierarchical multiple regression was used to identify the best predictors of EDI subscale scores, BMI, and glycemic control. Predictor variables were selected based on the available literature and included age, BMI, gender, Tanner stage, duration of disease, and obesity. For each model, we report the variables selected for inclusion in the model and which of these variables proved to be significant predictors (see Table 3).

RESULTS

Comparison with normative sample without diabetes

As shown in Table 2, compared with the normative sample, the male adolescents with type 1 diabetes in our study reported significantly fewer symptoms of bulimia, and the female patients with type 1 diabetes reported significantly less body dissatisfaction. The scores of neither the male nor the female patients were significantly different than the normative sample scores on any of the other scales.

Predictors of Body Dissatisfaction subscale scores

The literature suggests that female gender (22), older adolescence, and higher BMI are associated with greater body dissatisfaction (3,20–22). Therefore, gender, age, and BMI were tested as predictors of Body Dissatisfaction subscale scores. Al-

Table 2—*Mean scores on eating disorders inventory for study sample and normative sample*

	Study sample			Comparison sample*			
Scale	Mean score	SD	*n*†	Mean score	SD	*n*	T_w
Male subjects							
Body dissatisfaction	4.0	4.8	64	4.3	4.7	698	−0.498
Bulimia	0.7	1.8	65	1.2	2.4	698	−2.074‡
Drive for thinness	2.3	2.6	68	1.7	2.5	698	1.823
Female subjects							
Body dissatisfaction	8.6	7.1	75	11.3	7.7	675	−3.097‡
Bulimia	1.8	3.3	79	2.1	3.3	675	−0.765
Drive for thinness	6.6	5.3	74	5.6	5.9	675	1.523

*Comparison sample from Rosen et al. (22); †due to incomplete questionnaires, the sample size (*n*) differs for each subscale; ‡significance at $P < 0.05$.

Table 3—*Regression models predicting the EDI subscales, BMI, and glycemic control*

Dependent variable	β	*t*	*P*	r^2	Intercept	*F*
Body dissatisfaction				0.328	4.26	18.24
Gender	−0.54	−1.38	0.17			
BMI	−0.11	−0.47	0.64			
Gender × BMI	1.08	2.21	0.03			
Bulimia				0.205	1.96	10.05
Age	−0.15	−1.63	0.11			
Gender	−0.17	−1.41	0.16			
Age × gender	0.59	4.61	0.00			
Drive for thinness				0.556	0.128	53.82
Gender	0.12	1.38	0.17			
Body dissatisfaction	−0.05	−0.18	0.85			
Gender × body dissatisfaction	0.72	2.66	0.01			
BMI				0.057	21.54	6.41
Bulimia	0.21	2.26	0.03			
HbA_{1c}				0.122	8.06	4.55
Disease duration	0.25	2.61	0.01			
Bulimia score ≥5*	0.19	2.05	0.04			
Obesity†	0.16	1.70	0.09			

*The clinical cutoff score for the Bulimia subscale: coded 1 if above the cutoff, 0 if below; †BMI > 95th percentile for age and gender: coded 1 if above this percentile, 0 if below.

though there was no age effect, a significant gender-by-BMI interaction was found (Table 3). Consequently, regression models were run for male and female subjects separately. BMI continued to be a significant predictor for both male subjects ($t = 2.37$, $P < 0.03$) and female subjects ($t = 4.84$, $P < 0.0001$). However, BMI was a less powerful predictor for male subjects ($R^2 = 0.103$) than female subjects ($R^2 = 0.271$).

Predictors of Bulimia subscale scores

Because older female adolescents have been found to report higher numbers of bulimic behaviors (2), age and gender were both tested as predictors of Bulimia subscale scores. An age-by-gender interaction was found (Table 3). Consequently, the model was run separately for male and female subjects. As seen in Fig. 1, female subjects had higher Bulimia subscale scores than male subjects at younger ages. Bulimia subscale scores for female subjects peaked at 13–14 years and then declined. In contrast, Bulimia subscale scores for male subjects increased after 15 years of age. Only seven subjects in the total sample scored in the clinically significant range on the Bulimia subscale (score ≥5). All seven of these subjects were female; and six of these subjects were aged 13–14 years.

Predictors of Drive for Thinness subscale scores

The available literature suggests that older adolescence, female gender, higher BMI, and greater dissatisfaction with one's body predict greater concerns about thinness (22,24–26). Thus, age, gender, BMI, and Body Dissatisfaction subscale scores were tested as possible predictors of Drive for Thinness subscale scores. Age and BMI failed to be significant predictors, but gender interacted with body dissatisfaction (see Table 3). When separate models for male and female subjects were run, body dissatisfaction continued to be a significant predictor for both groups. However, body dissatisfaction was a more powerful predictor for female subjects ($t = 8.04$, $P < 0.0001$, $R^2 = 0.484$) than for male subjects ($t = 3.69$, $P < 0.000$, $R^2 = 0.185$).

Predictors of BMI

Previous research has documented an association between binge eating behaviors, female gender, and BMI (9). Consequently, Bulimia subscale scores and gender were tested as predictors of BMI. A high score on the Bulimia subscale significantly predicted a high BMI (Table 3).

Predictors of glycemic control

Age, duration of disease, Tanner stage, obesity, Drive for Thinness subscale scores, and scoring above the clinical cutoff on the Bulimia subscale (≥5) were examined as possible predictors of HbA_{1c}. Based on recommendations of the Expert Committee on Clinical Guidelines for Overweight Adolescent Preventive Services, obesity was determined as BMI >95th percentile for age and gender (23). In our sample, 10.9% of the patients were overweight, which is consistent with the prevalence found in a national sample (27).

The best prediction model included duration of disease, scoring above the clinical cutoff on the Bulimia scale, and obesity (Table 3). Scores on the Drive for Thinness subscale, age, and Tanner stage were not significant predictors. Overweight adolescents with a longer duration of disease who reported a significant number of symptoms of bulimia were considered to have the worst glycemic

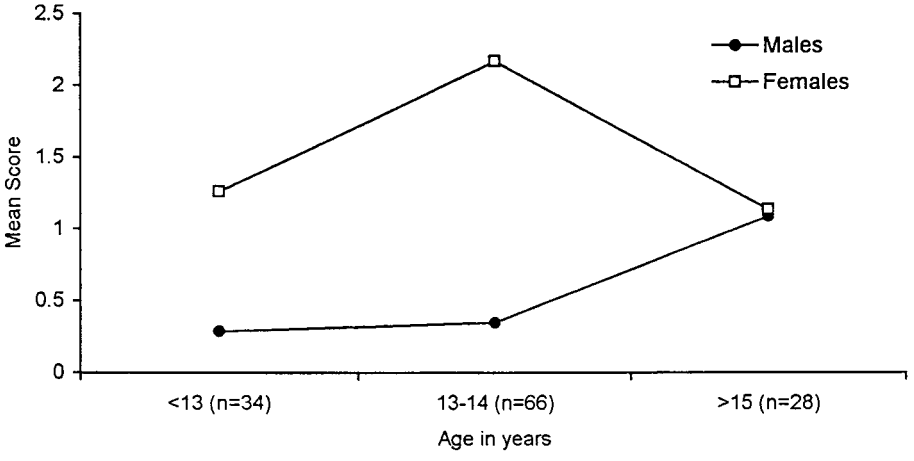

Figure 1—*Mean Bulimia subscale scores for male and female subjects divided by age categories.*

control. The regression analysis was rerun, treating BMI and Bulimia subscale scores as interval rather than categorical measures; there was no improvement in the prediction model.

CONCLUSIONS — This study found no evidence that adolescents with type 1 diabetes differ from the normative population without diabetes in terms of disordered eating attitudes and behaviors. In fact, in this sample, we found that male subjects reported fewer symptoms of bulimia and female subjects reported significantly less body dissatisfaction than the healthy normative population. In comparing our findings with those previously published, we found two studies with very similar populations and methodologies. Consistent with the findings reported here, Striegel-Moore et al. (11) found no significant differences in EDI scores between adolescent female subjects with type 1 diabetes compared with age-matched control subjects (11). In contrast, a more recent study by Engstrom et al. (1999) reported significantly higher EDI scores in their sample of adolescent female subjects with type 1 diabetes compared with age-matched control subjects (2). However, closer inspection of the data indicated that the age-matched control subjects in the study by Engstrom et al. had substantially lower EDI scores than the EDI normative sample used for comparison purposes in the present study (22). Also, the study by Engstrom et al. was conducted in Sweden, whereas the current study and the Striegel-Moore studies used American adolescents as subjects for comparison. Certainly, cross-cultural differences in body image, concepts of ideal weight, and eating behaviors are important considerations. In the U.S., female adolescents are known to have significant body image concerns and a strong preference for thinness as the "ideal" body type (3,7,19). The findings from this study suggest that American adolescents with type 1 diabetes exhibit body image concerns and eating behaviors remarkably similar to American adolescents without diabetes. However, the EDI is just one measure of body dissatisfaction and disordered eating attitudes and behaviors. Other assessment methods (e.g., diagnostic interviews) may yield different findings.

For patients with type 1 diabetes, the EDI is also limited by the absence of questions about manipulating or omitting insulin as a method of weight control, behaviors sometimes observed in patients with type 1 diabetes (28). In this study, we added two questions about insulin omission or manipulation to the EDI, identifying nine adolescents (four male, five female) who admitted to skipping shots or manipulating their insulin dose to lose weight. The small number of patients (6%) who acknowledged this type of behavior precluded us from using it as a predictor of glycemic control. Compared with previous reports, our study found fewer patients who admitted to insulin manipulation to regulate weight (6,9,10). The study by Peveler et al. (10) is the most comparable, consisting of 76 male and female adolescents with diabetes (11–18 years of age). Using a structured interview, they identified 5 of 35 female subjects (15%) who acknowledged omitting insulin or reducing insulin doses to lose weight. It is possible that a structured interview may be better able to detect this type of behavior than simply adding two items to a self-report questionnaire. The Peveler et al. sample was also slightly older than our study sample; insulin omission/manipulation may be more common in older adolescents and young adults. This hypothesis is consistent with other reports of insulin misuse in type 1 diabetic patients. Fairburn et al. studied patients aged 17–25 years; 37% of female subjects admitted to insulin misuse (9). Stancin et al. reported 40% of women with diabetes aged 18–30 years acknowledged efforts to control their weight by insulin purging (6). Consequently, insulin misuse for weight-control purposes may be gender- and age-related. However, it is worth noting that none of these previous studies reported insulin misuse in male subjects. In contrast, the current study identified four male and five female subjects who acknowledged this type of behavior. These findings suggest that it may be important to include male subjects in future studies examining the prevalence, etiology, and course of this type of destructive behavior.

As expected, higher BMI was associated with greater body dissatisfaction, although the association was stronger for female subjects than for male subjects. For females, a lower overall body size is socially construed as preferable, whereas for males, body dissatisfaction may come from being too thin or too short (24, 29,30). In this sample, being female and dissatisfied with one's body predicted drive for thinness. This finding is also consistent with current U.S. cultural preferences for smaller body size in white females: female adolescents with greater BMIs are likely to be less satisfied with their bodies and more likely to want to lose weight (24).

In the current study sample, female gender and age of 13–14 years were associated with an increased risk for symptoms of bulimia. In fact, the group of females in middle adolescence (13–14 years of age) was the only group to have a substantial number of subjects score in the clinically significant range in the EDI Bulimia subscale. It is interesting to note that male subjects did not report clinically significant symptoms of bulimia in any of the age-groups studied. Clearly, females seem to have more difficulty adapting to hormonal and physical changes associated with puberty and the onset of adolescence. In this study as well as normative healthy samples, girls consistently score higher on measures of body dissatisfaction and disordered eating (3,18, 19,22).

Longer duration of disease, scores higher than the clinical cutoff on the Bulimia subscale, and obesity were all related to poorer glycemic control. Previous studies have documented a link between eating disorders, such as bulimia, and glycemic control (4,7,8,10,14). In addition, obesity has long been associated with increased insulin resistance (31). Higher scores on the Bulimia subscale also predicted a higher BMI; subjects who engaged in bulimic behaviors tended to be more overweight. Consequently, symptoms of bulimia had both a direct and an indirect effect on glycemic control. A greater number of symptoms of bulimia was associated with poorer glycemic control, demonstrating a direct effect. A greater number of bulimia symptoms also predicted a higher BMI, which in turn was associated with poorer glycemic control, demonstrating an additional indirect effect of bulimia symptoms on glycemic control through BMI.

The EDI Bulimia scale seems to be a brief but reliable means of assessing bulimia symptoms in adolescents with type 1 diabetes. Using the clinical cutoff score ($\geq$5) on this scale may be a useful screening tool for busy clinicians who wish to identify those adolescents at-risk for an eating disorder, increased BMI, and poor

glycemic control. Because the scale is brief, we suggest that all adolescents and young adults be screened, although screening may be most important for females. Early identification and intervention may help prevent the serious health problems associated with bulimia in type 1 diabetic patients.

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